U.S. NAVY MEDICINE

March-April 1985

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U.S. NAVY MEDICINE is published from appropriated funds by authority of Department of the Navy, Naval Medical Command, in accordance with Navy Publications and Printing Regulations P-35. Second class postage paid at Philadelphia, PA, and additional mailing offices. ISSN 0364-6807. Articles, letters, and address changes may be forwarded to the Editor *U.S. Navy Medicine*, Department of the Navy, Naval Medical Command (MEDCOM 00D4), Washington, DC 20372-5120. Telephone (Area Code 202) 653-1237, 653-1297; Autovon 294-1237, 294-1297. Contributions from the field are welcome and will be published as space permits, subject to editing and possible abridgment.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

NAVMED P-5088

POSTMASTER: Send change of address orders to U.S. Naval Publications and Forms Center, ATTN: Code 306, 5801 Tabor Avenue, Philadelphia, PA 19120.

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Vol. 76, No. 2
March-April 1985

COVER: A Navy diver takes the plunge. The basics of diving medicine and treatment of diving-related illnesses is the subject of a two-part series beginning on page 21. Photo by PH1 Steven L. Waterman.

Why Do We Need It?

During my trips to the field, people often ask me, "Why do we need a quality assurance program?" "Isn't it time consuming?" "Doesn't it take a lot of energy and interfere with the increased productivity you're always emphasizing?" Even the Inspector General put the question to me on his visit of September 1984: "Why does NAVMEDCOM have a quality assurance (QA) program?"

An immediate response would have been simply that JCAH (Joint Commission on Accreditation of Hospitals) or higher authorities require treatment facilities to have one. But this question deserves a more thoughtful approach that goes beyond the mere fulfillment of a requirement. A more meaningful answer lies in the deep personal commitment I share with VADM Seaton and, hopefully, with all of you—a commitment to provide the best possible health care for our patient community.

I strongly believe that an effective QA program must be an integral part of our day-to-day operations and that without it our efforts would lack the needed tool to achieve the excellent quality we're striving for.

Let's look at the kind of program I'm talking about. I see QA as a management tool designed to monitor and systematically and objectively evaluate the quality and appropriateness of patient care. Using an ongoing, self-monitoring system, we can identify problems, resolve them satisfactorily, and pursue opportunities to improve patient care. The bottom line must always be accountability—the fulfillment of our moral, legal, and professional obligation to insure the quality of care delivered.

Based on the concept of peer review, our QA program is centered around a credentialing process which enables us to identify and examine health care providers' credentials before employing and granting them privileges. Those privileges are then reappraised, utilizing data from all QA activity, including input by the providers' peers.

While it is true that we have practiced QA concepts for a long time, what is relatively new is the introduction of the requirements for systematic, *ongoing* monitoring and evaluation of patient care activities, and the documentation of results. In the past, quality assurance floundered under masses of paperwork based on unproductive audits or studies. No wonder providers criticized QA for all that wasted paper "talk" and no action. Now, however, I am pleased to report we are making great progress toward ongoing corrective action with very positive results.

This takes me back to the initial question on the need for QA and the criticisms mentioned earlier. Isn't QA time consuming? Yes, it does take time and the time should be well spent. QA is a process that needs to be part of the day-to-day operation. It is not an inspection, a witch hunt, or bigger than life. At QA meetings, whether committee or departmental, participants are expected to summarize activities performed over a specified time and render decisions on problems of importance uncovered during the period in question.

QA does take people, too. It involves appropriate health care professionals, especially in the development of criteria and in decisionmaking. What went wrong? Was the care adequate and appropriate or inadequate? What are we going to do about the problem and when?

Results must, of course, be useful. Problems identified through QA must be corrected in a timely fashion. We can speed up the resolution if we exercise horizontal communication with the appropriate departments or committees rather than waiting for vertical response before taking action.

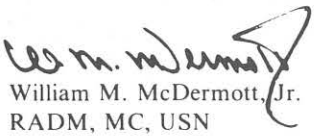
I know many of you are concerned about the recent push for increased productivity. Are QA and productivity objectives in conflict? Absolutely not. An effective QA program helps to identify areas of weakness that not only affect quality but also affect productivity.

One final note: Each of you wants to be a member of a top-notch organization and provide the best possible care within our resources, whether the care is delivered in a clinic or a hospital. This means that anything in the health care delivery system that detracts from quality or portends a lack of quality must be evaluated objectively and corrected accordingly.

There is, of course, a price that must be paid. Those of you who entered the Navy thinking someone else would be responsible for making decisions that affect the quality of care are experiencing a rude awakening. On the other hand, some of you are enjoying the personal satisfaction of initiating changes to make the system work better.

QA is a team endeavor. Yes, our efforts over the past few years have shown us that we need to refine our focus, intensity, and methods. This is only possible through your involvement. After all, your own practice and performance are evaluated through the QA program. Know the requirements of NAVMEDCOMINST's 6320.7 and 6320.8 and JCAH. Read the literature. Don't get your information secondhand.

Be a participant, not a spectator. Then the next time someone asks *you* the question, "Why QA?," you will be ready to give the answer with confidence and with pride.



William M. McDermott, Jr.
RADM, MC, USN

Dumpsters Become a Rescue Simulator

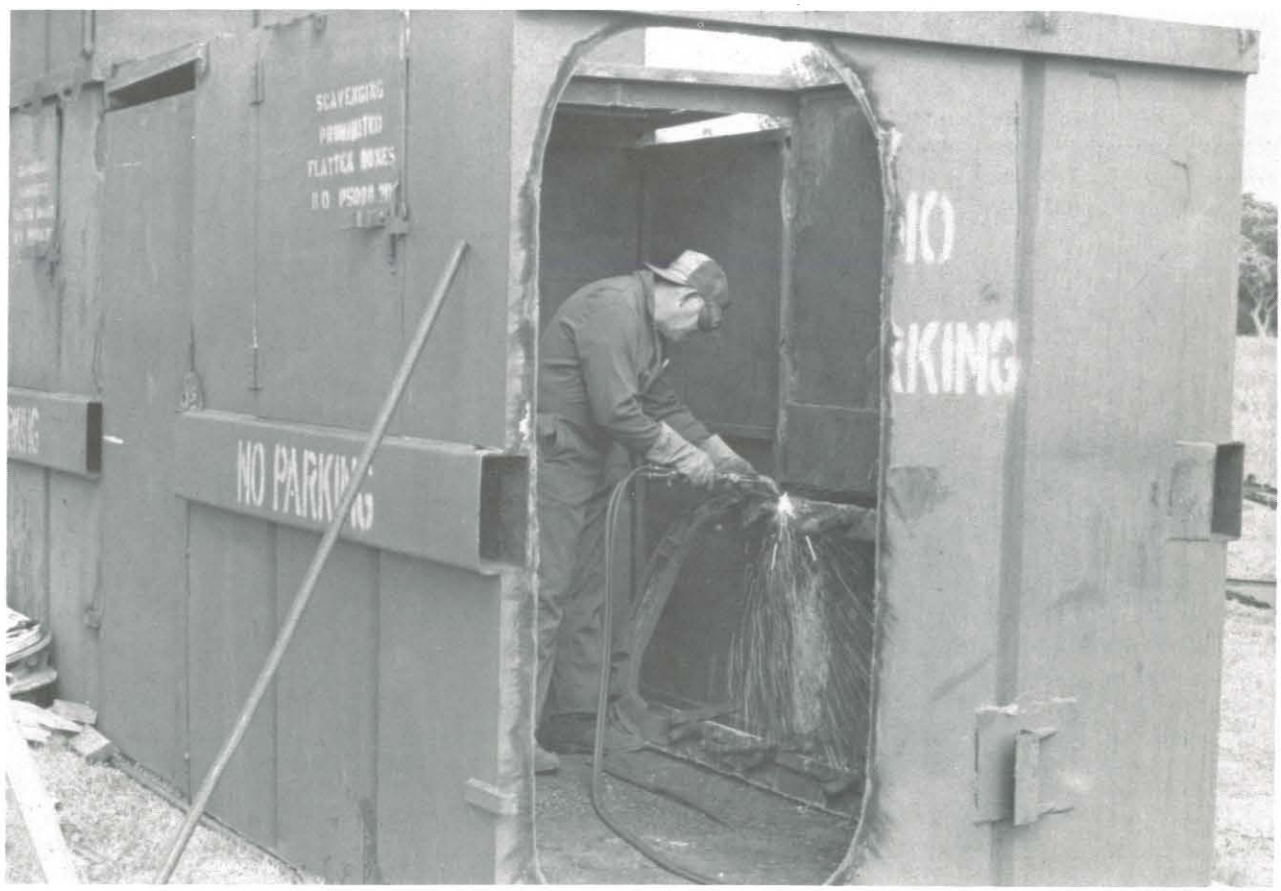
"The trainer looks as though you could cast off all lines, shift colors, and get underway," said RADM E.P. Rucci, MC, commander of the Naval Medical Command, Southwest Region. RADM Rucci was the featured speaker at graduation exercises for the first emergency medical technician (EMT) class to use the training device in simulating shipboard rescues and extrications.

"We wanted to familiarize students with emergency situations they will encounter aboard ship," said CWO4 Gene Jones, director for the Southwest Region's EMT program.

The Naval Medical Command at Marine Corps Base, Camp Pendleton, CA, provides EMT training to all naval personnel throughout the Southwest Region.

The trainer is the brainchild of CWO4 Robert Stevenson of the Naval Medical Clinics Command in San Diego, CA, and CWO4 Jones. Together, with the help of HM Gary Freston, a course instructor, they transformed three large trash dumpsters into the device. CWO4 Stevenson fabricated the hatches, railings, and other features which add to the authenticity of simulated exercises. "Most of the materials came from the Defense Property Disposal Office. The paint was donated by Navy SEALS and the hatches were donated by the San Diego Naval Station Fire Fighting School in exchange for class seats in the EMT course. No government funds were requisitioned to pay for any of the construction," explained Jones.

"It took 6 months to build the trainer, working on it between and after classes. There are many things that can be done with this device. We can simulate a fire in any one of the compartment spaces, interjecting various situations in which the students are required to effect a rescue or removal of injured personnel. We can also flood each compartment," said Jones.



CWO4 Stevenson at work: Converting the dumpsters required a good deal of welding.

"There are basically three special pieces of equipment used in shipboard extrications and rescues," continued Jones. "The Neil-Robertson stretcher, designed to move patients safely in tightly confined areas; the Stokes Basket for ship to ship transfers of personnel, and the Miller Body Splint. We expect to prepare our students to use this gear and familiarize them with working in the confined spaces of a ship or similarly limited areas."

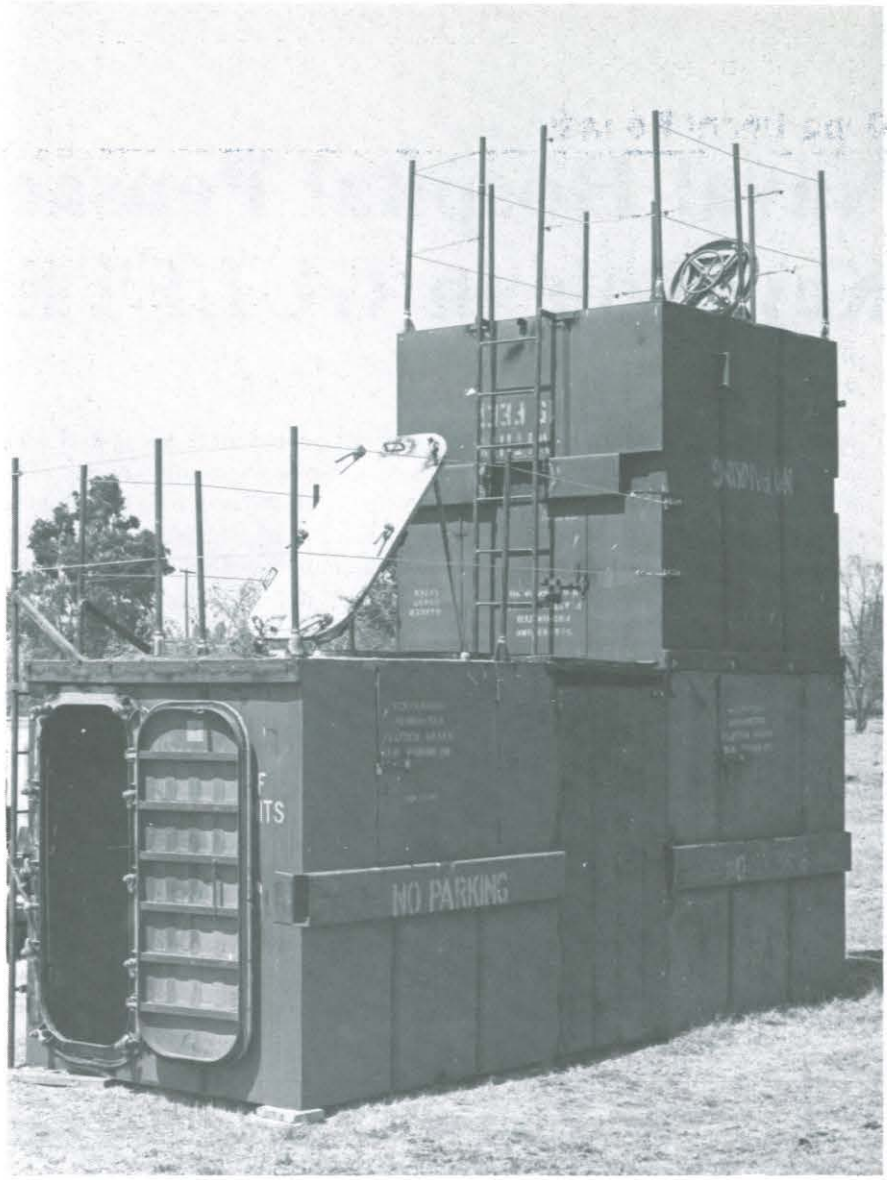
EMT training is offered about 10 times per year and averages 36 students per class. There is also a twice a year refresher course. Both courses are a unique blend of didactic and practical hands-on learning experiences.

CWO Jones is justifiably proud of the EMT program, especially with this latest addition of the trainer, built primarily by CWO Stevenson's skilled hands. "I tried to get some Navy shipfitters to install and weld the watertight hatches," Stevenson said. "But they were too busy so I did it myself. I weld as a hobby."

The program's reputation has spread by word of mouth. The performance skills demonstrated by course graduates, coupled with the recognized need for advanced training of corpsmen in the fleet has created a shower of requests for participation from many commands in the Southwest Region and even from other services and civilian counterparts. "It's one of the things that separates our program from others. We do what others talk about. We give our students a lot of practical experience. As far as I know, there is no other shipboard extrication training facility in the Navy," said Jones.

The trainer was christened following the graduation of the first class to use it. Named the USS *Casualty,* its designation is DSTC-1 (Dumpster Salvaged Training Compartment 1). □

—LT Gene R. Eliott, NAVMEDCOM SWREG, Public Affairs Officer, San Diego, CA 92134



Hatches open, the new training device is ready for action.

CWO Jones shows COMO Lewis Angelo, Director of the Medical Service Corps, aboard USS Casualty.

Naval Hospital Pensacola Plays Key Role in GULFTENOREX 85

It was a typical October Saturday morning in Pensacola, FL. A bright, pale blue sky with an unusually high wind brought cooler, pleasant temperatures making an ideal day for an excursion, an outing at the beach, or a quick sailboat run in the bay.

The telephone call came through the main switchboard at Naval Hospital Pensacola. M-Day. Mobilization Day. For the officers and men of Naval Reserve Readiness Command Region Ten, GULFTENOREX Day. The call had been brief and to the point. An "enemy" commando unit had parachuted into the area during the early morning hours. The Marine Reserve had responded and there would be casualties medevaced to the hospital within the hour. For the staff at the hospital, their day off would be interrupted. Although a drill, they take mobilization exercises seriously.

The established recall bill was set into motion and all medical staff who were at home were called back to the hospital. A recall is serious training for the reservist and active duty person. Within minutes most of the off-duty personnel had been notified and were on their way to man the emergency stations.

"We have space and equipment to handle 30 emergency cases—15 at one time. The hospital has 118 beds and an additional 35 beds can be activated instantly," explained CAPT A.M. Martinson, commanding officer.

Over 1,000 people work at Naval Hospital Pensacola, including 700 active duty personnel. In addition, Reserve components drill each month at the facility. All were cognizant of the "emergency" situation during GULFTENOREX 85 and most participated.

"We did not shut down routine hospital operations for this exercise." CAPT Martinson continued, "We treated the exercise as a real disaster. Over two-thirds of the staff came in to man critical areas such as OR and X-rays."

A temporary receiving station was prepared in the main hallway next to the emergency entrance. Teams of physicians, nurses, and corpsmen evaluated the wounded, tagged them for appropriate treatment or surgery. Five operating rooms were readied for the "casualties."

Under the direction of LT A.L. Knopp, the hospital's command chaplain, active duty chaplains comforted the "wounded" and administered the sacraments for a few of the "severely wounded" during the exercise.

HMCS R.D. Dunn, head of programming for this joint military exercise involving over 400 reservists from three states, observed that "evaluations proved that we made much improvement over previous GULFTENOREX scenarios. For one thing our combat survivability improved. Last year 80 percent of our corpsmen were "lost" during the "fire fight," while this year the umpires reported less than 10 percent casualties among the corpsmen."

This was the first time a hospital was brought into the exercise scenario. Dunn commented that Naval Hospital Pensacola served two important purposes: "to give field corpsmen experience in medevac using standard equipped helicopters and to give the hospital staff practice in a mass casualty drill."

GULFTENOREX 85 demonstrated that realistic training is essential to prepare units for mobilization readiness. "Overall, the entire scenario of simulated combat, field medicine and evacuation plus hospital involvement

Active duty hospital corpsmen assist "a casualty" in a surgical suite at the hospital. Note the realistic moulage strapped to the "patient's" right arm.

proved to this Readiness Command that our training is on the right track. We recommend this type of exercise for every medical support detachment at least one weekend per year," said Dunn.

Commanded by CAPT Roy C. Stoddard, Naval Reserve Readiness Command Region Ten, New Orleans, the originator of GULFTENOREX exercises, will according to Dunn, "continue to make this type of training available to all medical support units within the command every year."

Both active duty and Reserve personnel discovered again the importance of simulated casualty training during a mobilization exercise. If a real "M-Day" occurs, the medical support detachments in Readiness Command Region Ten will be better prepared thanks to the support of Naval Hospital Pensacola.

—Story and photos by JOC Jim Hall □

Hospital Corps/Dental Technician Update

• **Retention.** The Hospital Corps and Dental Technician ratings are presently experiencing an exceptionally high percentage of reenlistments. At the present time, first-term reenlistments are: HM's 61.4 percent, DT's 58.9 percent. Overall Navy reenlistments are exceeding expectations by 10 percent.

• **Selective Reenlistment Bonuses.** CNO, Washington, DC Message 231922Z Nov 84 (NAVOP-142-84) announced the following SRB changes:

HM-8482 Pharmacy Technician—Deletion of the SRB due to sufficient manning levels.

HM-8492 Special Operations Technician—Zone A Level 3.5; Zone B Level 3.

HM-8493 Medical Deep Sea Diving Technician—Zone A Level 3.5; Zone B Level 3.

(The aforementioned HM NEC SRB changes will be closely monitored and reevaluated in six months).

• **"C" School Application/Selection.** Selection for a "C" School is extremely competitive. Career counselors are reminded of the importance of complete package submissions to include all enclosures as directed by current CANTRAC requirements. Also, applicants are strongly encouraged to retake ASVAB tests when minimum requirements are not satisfied to insure competitiveness.

• **Critical NEC's.** The need currently exists for the following HM specialties:

HM-8425 Advanced Hospital Corpsman
HM-8492 Special Operations Technician
HM-8432 Preventive Medicine Technician

(Contact your command career counselor for further information).

• **Advancement.** The number of selectees for the Fall '84 cycle were significantly greater than those for Spring '84. This increase is due to a 4 percent growth in hospital corpsman end-strength for FY85. Fall '84 advancement numbers are as follows:

			General	Prosthetics	Repair
HM1	288	DT1	5	1	2
HM2	675	DT2	22	2	2
HM3	1,150	DT3	90	9	N/A

Congratulations to all HM's and DT's selected for advancement.

• **Significant Enlisted NAVMEDCOM Personnel Changes:**

HMCM Thomas Eagles, Enlisted Education and Training (Assistant Division Head), Autovon 294-1821/Commercial (202) 653-1821

HMCS R.W. Smith, Career Development (Assistant HM Plans Officer), Autovon 294-1647/Commercial (202) 653-1647

DTCS J. Ingram, Assistant to the IG for Enlisted Affairs, Autovon 294-1138/Commercial (202) 653-1138

DTCS K. Phipps, Force Master Chief Administrative Assistant, Autovon 294-1148/Commercial (202) 653-1148

HMC J. Foley, Assistant for Reserve Affairs, Autovon 294-1245/Commercial (202) 653-1245

DTC R. Beers, Administrative Assistant to the Director, Medical Care Division, Autovon 294-1122/Commercial (202) 653-1122

DTC J. Bushnell, Administrative Assistant to the Director, Dental Care Division, Autovon 294-1170/Commercial (202) 653-1170

• **HM/DT Career Plans and Rating Specialty Advisors:**

HMCM W. Raysick, Autovon 294-1647/Commercial (202) 653-1647

DTCM J. Wall, Autovon 294-1647/Commercial (202) 653-1647

Medical Department Career Progression: Flag Officers' Perspectives

LCDR James M. LaRocco, MSC, USN
Ellen Kumata

As the complexities of health care delivery increase, the Navy Medical Department faces many challenges. One is to develop officers committed to and trained to provide good patient care on the individual level and also to command and manage the entire health care system. It is imperative that those qualified are first trained and then retained so they can grow and mature into positions of leadership.

An important factor in meeting this challenge is the design of a well defined but flexible career ladder that provides every officer, regardless of corps, the opportunity to train and to demonstrate the potential for increased leadership responsibility at critical points throughout a naval career.

What are the critical points? What is an ideal career progression? The Medical Department is presently addressing these questions as part of its management development effort, and guidelines are being prepared to assist all officers in career planning. In the interim, this article reports on data drawn from an analysis of interviews with 17 flag officers. The interviews were conducted by trained interviewers from the civilian contractor responsible for developing the Medical Department's leadership and management education and training (LMET) program.

During the interview, which typically lasted about 2 hours, each interviewee was asked to discuss in detail:

- individual career history,
- billets that were key in developing leadership and management skills,
- suggestions for design of a career path for health care officers, and
- opportunities for introducing LMET into the career development process.

Although the interview sample included members of all four corps, the present flag distribution resulted in the majority of the interviewees being from the Medical Corps; the views presented here reflect that fact. Nevertheless, there were striking career history similarities among all the interviewees. This observation is not surprising, given that all were high level health care executives: their "subspecialty" was executive medicine; their common experience—leadership and management in the naval health care system.

Individual Career Histories

When the interviews were analyzed, common factors emerged among the officers' career histories. They had become health care professionals in order to provide health care and not necessarily to manage its delivery. Over half the group explicitly stated that early in their careers they had experienced little interest in administration or command. There were a few exceptions, but most said they had no definite plans to seek a command position.

For most of these officers, initial involvement with the Navy resulted from the attractiveness of a naval internship or the inevitability of being drafted. The Medical, Dental, and Nurse Corps officers all attended civilian universities, where they concentrated on clinical skills and had minimal Navy contact. Because the educational process was long and rigorous, a predominantly clinical orientation was ingrained by the time most became naval officers.

First Operational Tour

An operational tour directly after internship for medical and dental personnel establishes one's initial, critical commitment to the Navy. It not only exposes the individual to the line and its health care needs, but also gives the officer an opportunity to appreciate how he and the Medical Department fit into the entire naval organization. The interviewees all agreed that the experience was broadening.

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The first operational tour also provides military management responsibility, sometimes even planting the seed of a career in executive medicine. On this tour the interviewed officers, as department heads or members of a small department, were given responsibility for budgeting, supply, and personnel administration. They were also exposed to different departments and learned how to cooperate with those departments.

An early operational tour is important because it:

- establishes a commitment to the Navy,
- gives one an appreciation for the needs of the line,
- provides early exposure to military management responsibility,
- teaches one to work with and lead people,
- allows one to determine areas of interest for future specialization, and
- gives birth to a network of contemporaries; these contemporaries will become one's colleagues at flag level.

Role Models, Mentors, and Sponsors

Every interviewee credited at least one key person, if not several, with helping him develop into a better officer and leader. Role models and mentors were most prevalent at the beginning of the officers' careers, particularly on the first operational tour. They were also common later on when the interviewees were executive officers or held other senior positions. This was not surprising, since new duties and responsibilities were introduced in these billets, causing the officers to seek advice and examplars.

In early operational tours, the interviewees found senior enlisted personnel to be very helpful in teaching them elementary administrative duties and procedures. Most said their chief or first class petty officers had been of particular help, and that by seeking their advice they had learned a great deal.

Having a sponsor, once one shows managerial potential, is also crucial, as demonstrated by the interviewees' experiences. Most that made it to very top leadership positions had a sponsor, someone who had identified them early as potential executive material. Because of their belief in the value of role models, mentors, and sponsors, the flag officers themselves now serve in those capacities. Most have their eye on people who show evidence of managerial ability. Moreover, they are quick to use and develop those people by placing them in positions of responsibility on various committees, boards, and giving them special assignments that arise.

Advanced Training

All the officers had advanced academic training, either on the graduate level or, in the case of physicians, residencies for specialty training.

Advanced training occurred at different times during their careers. The timing of this training was important. For all but one person, it was after they had been on operational tours. The flag officers said that advanced training is more appropriate after one has been exposed to the line and has had time to mature professionally. Moreover, had they gone directly into advanced training, it would have been a poor use of resources to have then assigned them to ships or to foreign duty stations as general health care officers. This would have underutilized the specialized skills they had developed and would have been counterproductive in establishing a commitment to the Navy.

From the perspective of executive medicine, advanced training provides all health care officers, regardless of corps, with the opportunity to fill positions such as department head, service director, and program manager. It also enables the individual to gain the concomitant visibility necessary for managerial advancement.

Large Hospital Experience

Another common denominator among those interviewed was that they had all served in large hospitals or other health care centers. Because administrative responsibilities are complex at large institutions, this exposure was valuable both professionally and managerially. Being a service director in a large health care establishment was seen as having been a good opportunity to develop leadership and management skills.

As with the operational tour, exposure and responsibility were the important factors in the billet at a large health care facility. Again, role models and mentors aided the learning process. The critical element was that the senior officers in the large institutions delegated responsibility to the interviewees. Repeatedly, these flag officers stressed the importance of such delegation for developing skills in executive medicine.

Washington Experience

All officers had held a headquarters billet in the Washington, DC, area prior to becoming a commanding officer. Uniformly, they said that this experience was important in getting a systemwide view of health care operations as they relate to overall Navy operations. One remarked, "It gave me an opportunity to see how the upper echelons operate. There's a process that's completely different at the highest levels, which you can't possibly imagine if you're at a lower level." To become an effective leader, one must recognize the Navy's structure early in one's career. A Washington tour exposes a person to this structure.

Washington exposes officers not only to the complexities within the Navy but also to the interactions between the Navy, Department of Defense, and Congress. Such an experience provides an opportunity to acquire an overall view that is essential in senior leaders.

Commanding Officer Experience

Not all the flag officers had served as executive officers but they all had served as commanding officers and thereby exercised broad managerial authority. It is apparent from their career histories that commanding officer duties challenged them to continue development of their leadership and management skills.

An important factor for them all was the high degree of action associated with discharging the responsibility of command. The interviewees said: "Command is where the action is." "Command is where the rewards are." "Command is where you can see you have influence." "You can direct." "You can guide . . . and that's where the fun really is."

The interviewees reported that learning to manage large, diverse groups of people, and the importance of delegation of duties was the key to keeping a large organization functioning smoothly. One said, "The key to success in command is to know how to get work done through people." All said they enjoyed working with people. "To be a good commanding officer you have to really care about what is going on with your people. You have to trust them, train them, and let them do their jobs."

Leadership and Management Training

The interviewees were asked to specify the courses that would have been helpful to them early in their careers. The majority said that training in financial management would have been very helpful. The importance of legal aspects of command was also deemed important.

In recommending courses, the consensus was that a blend was needed. This, in conjunction with on-the-job experience, would prepare officers for management. They felt a series of courses should extend throughout one's naval career. Although they made a few specific suggestions for course content (financial management, supply, law, human relations principles), these flag officers were more concerned with the overall career approach.

Finally, the interviewees noted the need to identify management potential in officers early on, yet not to preclude late bloomers. They felt that it is an investment in people that must be made in order to insure good future leaders and managers. "There are no quick fixes in this business," said one admiral. "We're dealing with human beings, and we should be investing for 10-12 years down the pike in these people." The officers recognized that leadership and management ability is not acquired in just one course. The career-long approach was described as a "programmed learning course, so that by the time the person is an admiral, he or she has some basic common knowledge that is pertinent and of value."

Summary

The implied assertions in the flag officers' interviews are clear:

- an idealized career path might well contain an early exposure to an operational tour with the fleet or FMF followed by specialized training, hospital experience, and headquarters experience,
- the Medical Department should assist an individual's attempt to pursue this course,
- the Navy should both recognize and encourage potential leaders and managers,
- courses exist to promote competence in leadership and management, and
- methods exist to assess performance and select for executive position individuals who are qualified for such jobs.

Having mentors, role models, and sponsors are critical to career development. Often one person serves in all capacities, teaching and guiding the officer, setting an example, and also facilitating the officer's advancement in the system by promoting his talents to others in the corps. Similarly, the outstanding officer will develop a network of contacts as he progresses through his career. The individual thus builds both skills and a solid reputation within the Medical Department.

Finally, the ability to recognize opportunities for advancement and to act on them, plus the attitude that each billet presents a chance to learn skills, are traits of outstanding health care executives. Thus, not only must one see a career path, one must also take an active approach to it, i.e., possess a willingness to make that extra effort to acquire and demonstrate leadership skills and potential.

A major impetus of the restructuring of the Medical Department was the need to improve the way we train, select, and assess medical personnel for executive positions. What this will mean for the future is that men and women who will be commanding officers and flag officers 15-30 years from now will be chosen on the basis of specified experiences, training, and demonstrated competence in leadership and executive medicine. To accomplish this goal, leadership and management opportunities for personnel are being identified, and many of the experiences and recommendations of the current flag officers are being reviewed, distilled, and used in establishing an overall career progression policy. More importantly, the opportunity for leadership and management training will be integrated into the career progression of Medical Department personnel. Command screening boards have been created to insure that the best qualified individuals are selected for senior leadership positions. □

Challenges in Education: Applied Microprocessing

HM1 Nancy L. Duffy, USN

The Continuing Medical Education and Training (CME) Department at the Naval Hospital, Bremerton provides and supports the orientation, in-service education, continuing education, and on-the-job training for all categories of personnel on the staff. This function incorporates the coordination of a clerical and teaching staff, medical library, audiovisual department, and medical photography laboratory. In November 1982 CME received a long awaited and much anticipated Apple II computer with a 48 kilobyte random access memory, dual disk drive, cathode ray tube (CRT) and Integral Data Systems hardcopy unit. Since then the CME Department has computerized the major facets of the department's functions, consolidated the career counseling and nursing education branches, and provided the entire command with better service than ever previously available.

The CME Department had several problems the staff hoped the Apple II would help solve, but the first one to overcome was the lack of computer literacy. The department head had a personal computer, but neither the division chief nor LPO had ever sat at a keyboard before. Formal training was not immediately available; the local community college would not be offering computer introduction classes until January and TAD funds for computer literacy classes were not a priority at that time. Working on the principle that practice is the best way to learn a skill, the staff began a self-study program using tutorials that came with the pre-programmed disks. They began with a variety of basic programs: DOS 3.3, which teaches users about the Disk Operating System (DOS) and the various DOS commands; Applewriter II, a flexible work processing program; and VISIFILE, a data management system. They eagerly "assimilated" languages, commands, and formats, and many evenings a member of the staff would return to the office to test options and "de-bug" (correct errors). After about 4 months they had reached a point of functional understanding and felt ready to use the computer as an instrument to assist in the management of the department's workload.

The first truly operational computerized file was established with the VISIFILE program for the advancement eligibility data. Each enlisted staff member has been entered by grade, completion data of each military leadership exam, military and professional course, and time in rate. The report provides a worksheet which helps to recognize those members who have completed their requirements for advancement and to verify the lists sent by the Personnel Support Detachment.

Using similar formats, progress was made geometrically. Detailed data files were soon developed for the career counselor, enabling him to track required interviews and retention packages. Comprehensive education files were compiled which document general hospitalwide inservice training, credited continuing education classes, college courses, and conferences. Several Reserve data files were created to record the billets and training of the eight Reserve units attached to the command. And files which reflect the budget status for the entire department were developed. The information which had previously required repetitive researching and hand filing is now contained on a dozen diskettes available for immediate access. "Recipe cards" have been developed for each of these files describing the particular formats and commands required to run the program accurately, which in turn familiarizes new staff members with the system.

In addition to the statistical reports and worksheets, the VISIFILE system has provided the solution to one of the largest problems—the maintenance of current individual training files. In the past the CME Department would receive a roster of students attending a particular training session. The first step would be to pull each individual's folder, transcribe the class, and refile the folder. The second step involved again transcribing the same information onto feeder sheets for the hospital's mainline computer. Semiannually the CME Department would receive a

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printout for verification. This procedure caused three specific problems. First, the duplication of effort kept the staff several weeks behind and reduced program planning and execution time. Second, since training folders were kept only on the enlisted staff, the CME staff had no way of verifying attendance or certification requirements for the officer and civilian medical staff. Third, there was no standardized procedure for the submission of training rosters, so many classes never were recorded. Not surprisingly, JCAH (Joint Commission on Accreditation of Hospitals) did not view this favorably. With the VISIFILE program the staff developed an additional report format which provides individual pages for each member's file without adding additional data. Individual records are run off at 3- to 6-week intervals, depending upon the cumulative size of the file, and are distributed to the appropriate coordinators.

Using the word processing programs ("Applewriter" and "Magic Window"), the CME staff created routine memos, handouts, self-study programs, schedules, tests, and a wide variety of worksheets. This has reduced the number of reprographic requests by nearly one-third because the masters are permanently stored on diskettes, the originals are updated easily, and the need for storage space has been eliminated.

The benefits of the CME Apple II have been felt throughout the command. The division chief petty officers are able to pinpoint members who are overdue in completing their advancement requirements. Supervisors are coming to CME to review training folders prior to writing evaluations. Standardization of program submission and retrieval procedures has encouraged the entire staff to become more aware of inservice requirements and aided in the development and documentation of departmental programs. Staff members submit certificates for off-site TAD, college courses, seminars, and conferences with continuing education credits for inclusion in their individual files. Credentialing files have current educational input instead of being updated annually. CPR, medication, and IV certification status worksheets are sent to each department quarterly to assist supervisors in scheduling recertification and refresher training. Statistical reports of mandatory classes help to establish needs and to plan programs for future presentations. Comprehensive reports of operational readiness training or equal opportunity training are immediately available upon request. Other departments within the hospital have similar hardware components and when a programming problem arises, the CME staff becomes a resource to help solve the problems. Areas that do not have computers have come to the CME Department to test theoretical applications before making the initial investment in a computer for their department. Even the commanding officer has spent some time on the Apple II, learning the languages and trying new applications. As a result of these interactions, the CME Department has gained new respectability. The staff has demonstrated that computerizing can mean progress.

For those readers experienced with microprocessors, these achievements may seem very basic and routine, but for this staff, the job satisfaction and the opportunities to learn during the past year have been particularly rewarding. In addition to the technical advancement, each member is constantly stimulated to develop new applications and as a result they are consistently bringing better ideas into the department and providing better services throughout the command. The computer has brought innovation, challenge, and, most importantly, cost efficiency into the workplace. □

Navy Medical Care

The CNO, CMC, and I want to add a comment to recent news reports drawing attention to incidents of unsatisfactory military medical care. Press attention has focused on a handful of examples. These reports create an erroneous overall impression in and outside the Navy Department regarding the quality of Navy medicine. This fosters unwarranted apprehension about the quality of medical care throughout the naval service.

The record is clear. We are beneficiaries of a superb health care system. Recent reports have demonstrated we maintain a standard of quality that civilian medical service should strive for. We have major efforts underway to make it even better. Our medical departments are manned by highly qualified doctors, dentists, nurses, corpsman, and other health care professionals. We are also working to insure the Navy's budget contains the dollar resources necessary to sustain and improve your health care. From the Surgeon General to the most junior corpsman, you can expect and should express the quality medical care our people merit. —John Lehman, Secretary of the Navy

Reserve Support at Naval Hospital Newport

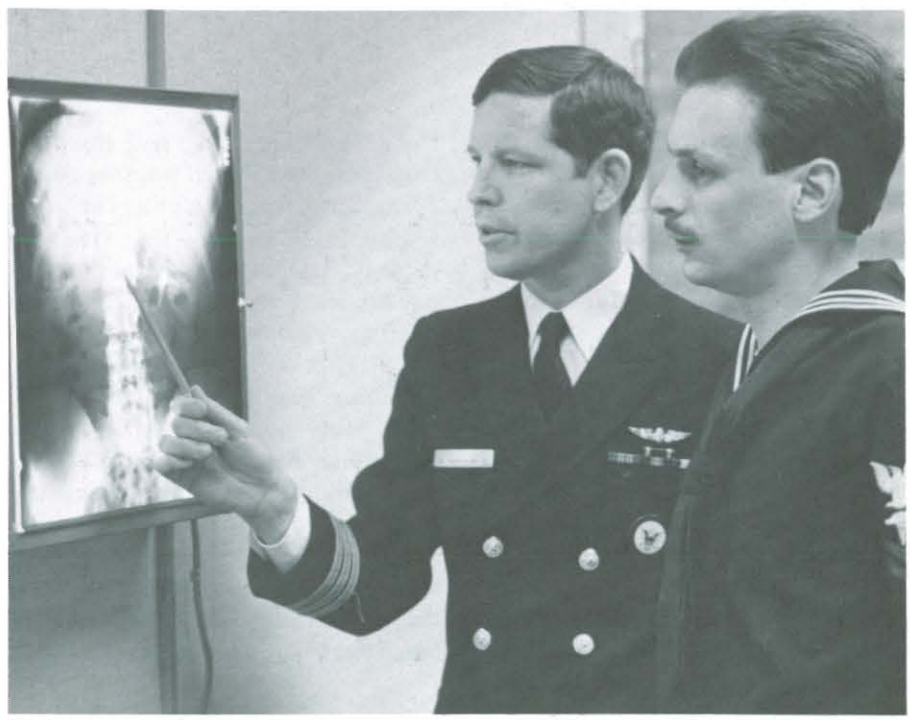
CDR Gary P. Kearney, MC, USNR-R
CAPT James Kurtis, MC, USNR-R
CAPT Robert Duhamel, MC, USNR-R
CAPT Thomas Clark, MC, USN

Enhanced job satisfaction, increased retention of personnel, and substantial Champus savings have been a few of the results of Naval Reserve Naval Hospital, Newport 101 (based at the Naval and Marine Corps Reserve Center, Providence, RI) actively drilling at Naval Hospital, Newport, RI. Services provided by Reserve personnel as they carry out their primary responsibility of training for mobilization resulted in savings of more than $100,000 in direct patient care during FY84.

Naval Hospital, Newport is one active duty facility at which Reserve medical forces drill. In 1983 VADM Lewis H. Seaton, Director of Naval Medicine, directed and NAVMEDCOM mandated the integration of Reserve and active duty medical forces. This integration has been very successful: a 1984 NAVMEDCOM survey of a 10-month period validated 8,000 Reserve physician man-days in direct patient care as reported by each medical facility providing considerable dollars of Champus savings. This does not include the effect of Nurse Corps, Medical Service Corps, physician assistants, hospital corpsmen, and Dental Corps programs.

At Naval Hospital, Newport, 5 physicians, a physician assistant, 10 Nurse Corps officers, 3 Medical Service Corps officers, and 30 corpsmen fulfill their Reserve requirements. Assignments make use of their professional expertise to provide consultation, outpatient, and inpatient care to active and retired personnel and their dependents in the Newport catchment area.

The physicians perform consultations within their areas of expertise and carry out specialized diagnostic and therapeutic procedures. The gas-



CDR Gary P. Kearney, MC, USNR-R, explains an intravenous pyelogram to HM2 William Landi, USNR-R, during the urology clinic.

Dr. Kearney is a staff urologist at Naval Reserve Hospital, Newport 101 and urologic surgeon at Brigham and Women's Hospital, Boston, MA. Dr. Duhamel is commanding officer, Naval Reserve Hospital, Newport 101 and chief of radiology at Waltham Hospital, Waltham, MA. Dr. Kurtis is staff medical officer at the Naval Reserve Readiness Command Region 1 and chief of pathology, South County Hospital, Wakefield, RI. Dr. Clark is commanding officer, Naval Hospital, Newport, RI.

Photos by LT Floyd Connelly, MSC, USNR-R

Naval Hospital, Newport is the mobilization site and provides facilities for Naval Reserve Hospital, Newport 101.

troenterologist performs colonoscopy, gastroscopy, and sigmoidoscopy. The pediatrician provides well-baby and school physicals, schedules appointments, and sees children who are acutely ill. The ophthalmologist enhances the training of the staff ophthalmologist in intraocular lens implantation and assists him in surgery. The urologist performs intrahospital consultations as well as performing minor surgical procedures including vasectomy and cystoscopy. The pathologist reviews difficult cases, helps with the laboratory, and assists in JCAH (Joint Commission on Accreditation of Hospitals) certification.

The nursing staff and hospital corpsmen contributed approximately 1,500 man-hours during 1984 at Naval Hospital, Newport. They staff the urology, pediatric, and ophthalmology clinics as well as augmenting the pharmacy, laboratory, and emergency room. They work on hospital wards, replacing and providing relief for active duty personnel. Most of the Reserve service occurs on drill weekends while personnel are completing training requirements.

The excellent cooperation between the active and Reserve components of the hospital allow full use of the hospital's facilities. This program has been and is successful due to this cooperative effort. Similarly, the support of the Naval Reserve Readiness Command, Region One and Navy and Marine Corps Reserve Center in Providence in assigning Reserve personnel to the same unit over the past several years has allowed long-term planning.

The program results in direct benefits for the Navy. The Navy realizes significant Champus savings and receives additional staffing for its clinics and hospitals. The reservists have the satisfaction of providing care commensurate with their level of training and of knowing that they are providing a necessary service. □

Reservists Provide Solution

JO2 Richard Gorham, USNR JO3 Julia Kingsley, USNR

Seldom has a set of problems found a solution quite as effectively as the success story being played out monthly by Hartford and New Haven hospital corps reservists and their active duty counterparts at the Submarine Base Groton Naval Hospital.

Problem No. 1. On weekends the base hospital's emergency room is the only military outpatient facility available for local active duty and retired military personnel and their families. As you might imagine, given the large military and dependent population of the SUBASE, many patients pass through the doors of the ER on a typical weekend. The ER staff must respond to and treat patients with severe injuries and life-threatening conditions before nonemergency patients. Consequently, a patient with an uncomfortable, but nonemergency condition, such as a cold, is often required to wait. The wait for care can seem interminable, a situation that is aggravating for the staff as well as the patients. Indeed, a problem begging a solution.

Problem No. 2. The well trained and motivated reservists attached to the Naval Hospital Detachment 201 in Hartford and 101 in New Haven were confronted with a problem common to many reservists: How does he or she apply their skills in an effective, meaningful way on drill weekends and gain new training and experience that will lead to personal advancement? Nothing is more frustrating or boring for the committed reservist than not having the opportunity to perform in their chosen field in a meaningful way.

Through a cooperative relationship developed between the active duty staff of the naval hospital and the reservists of Detachment 201 and 101, a common solution to both problems has been found and implemented. Initiated through the combined efforts of LCDR Kathleen Morrison, special assistant for readiness at the Groton Naval Hospital, and LCDR Russell Tonkin, commanding officer of Detachmment 201, a Primary Care Unit has been established at the hospital to augment the services offered by the ER staff on weekends. Manned by reservists assigned to Detachment 201 and 101, the Unit's mission is to meet the medical needs of less seriously injured or ill patients seeking care.

"We have reduced the patient waiting time from an average of 2-3 hours to 15 minutes, in most cases," says LCDR Morrison. "The reservists are providing an invaluable service. They are, as a group, well trained and highly motivated and are totally dedicated to providing the best patient care in the most effective manner. We could not begin to operate the Primary Care Unit without them."

CDR P.E. Dould, executive officer of the Groton Naval Hospital, views the real value of the program as the furthering of the "one Navy" concept. "Indeed, I can think of no finer example in the medical area that demonstrates the ability of our reservists to step into a given situation and directly affect the quality of care provided to our patients. Morrison and Tonkin and their staffs are to be commended for developing a program that works for all," said Dould.

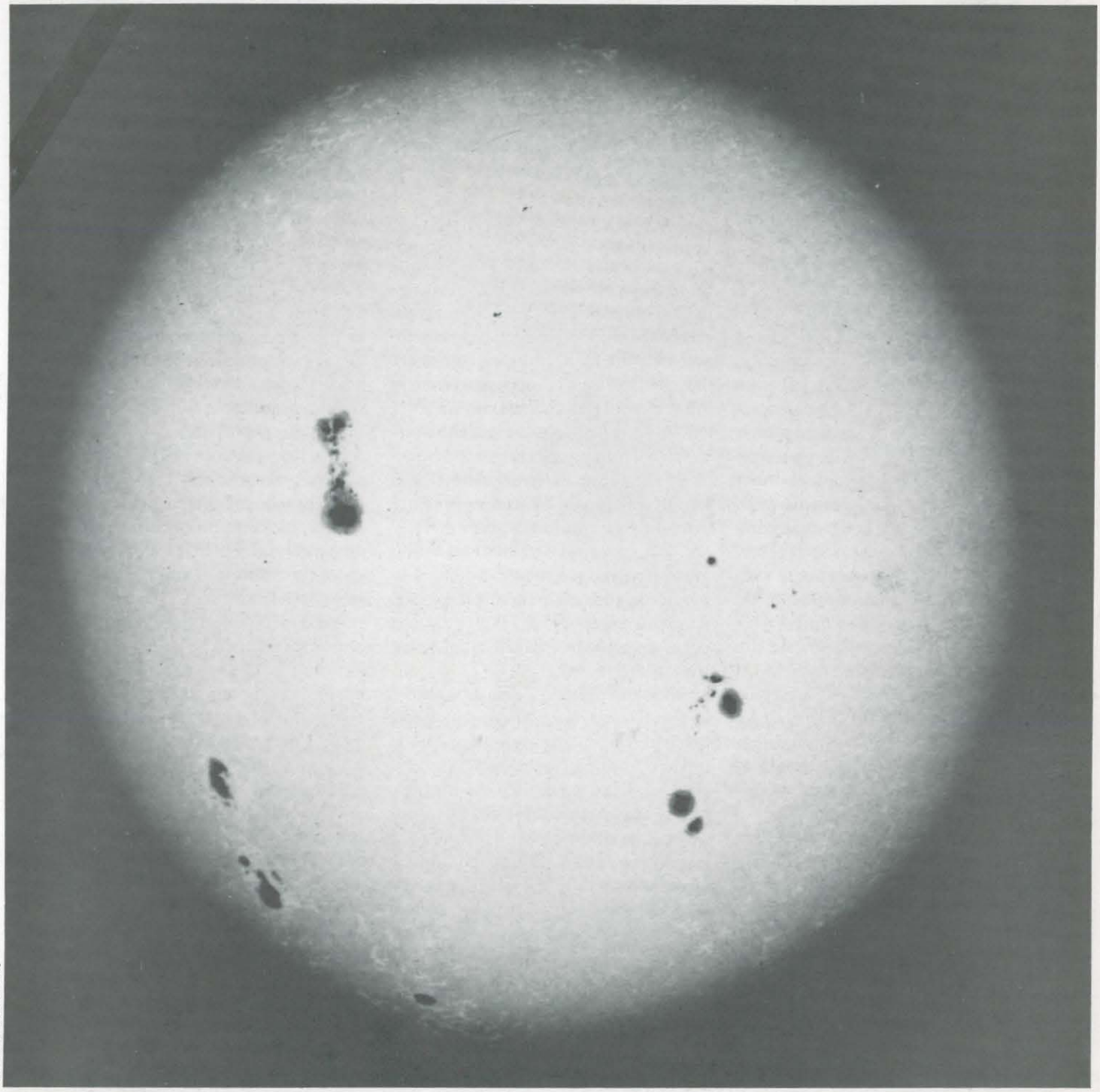
"The key," says Morrison, "is the command support from both REDCOM ONE and the commanding officer of the Hartford Reserve Center. They have, by their support, made the reservists available to us so we can develop a program with lasting results —one that we and our patients can continue to rely on and expand in the months and years to come."

The duties and responsibilities of the reservists assigned to the Primary Care Unit are as varied as their individual specialties. Doctors of internal medicine, nurse practitioners, and hospital corpsmen all work to fulfill the needs of the patients.

On one Saturday in September, Detachment 201 and 101 reservists helped to provide 70 children of dependents their required school physicals. "With the beginning of a new school year, we were inundated with requests for school physicals," stated LCDR Morrison. "In no way could our regular schedule meet the need. I contacted the reservists to seek their assistance in the matter, looking for a solution, maybe 40 physicals? Their response was the more the merrier, bring them on. So, we scheduled 70. We were completely booked within 48 hours of the initial announcement. This kind of service saves a lot of money for our dependents, considering that the average charge for a physical is roughly $35-$40. Once again, our reservists responded to the challenge with better patient services."

HMC Bob Sanborn, Reserve liaison for the Groton program, sees several benefits from the reservists' point of view. "Our unit morale is high, the best ever. Everyone enjoys and appreciates the opportunities this program presents to us. The hands-on training we receive is invaluable. More importantly, we feel wanted, that we are a part of the Navy team, if you will. What could be better."

Two major problems have been solved through the mutual cooperation of the naval hospital staff and the men and women of Naval Hospital Detachments 201 and 101. What could be better. □



U.S. Naval Observatory

Sunspots

The Sun and Your Health

CDR Jack P. Keeve, MC, USNR (Ret.)

The Class G2 average star 93 million miles away from us, that the ancient Egyptians called Ra and we call the Sun, is the mother of all life here on planet Earth.(*1*) It is the main engine that not only drives us and our environment but also shapes our culture in almost every respect. Although the Sun's importance has never been doubted or undervalued since prehistory, only recently have we begun to appreciate how complex it is and how it affects our health.

The early atmosphere probably formed from gases given off from the Earth's interior and volcanoes and matured with gaseous byproducts of the biosphere.(*2*) Without the thin and delicate skin of atmosphere surrounding us, life on Earth would not be possible. In eons past, before the modern biosphere matured, living things probably originated in the protective depths of the ocean or terrestrial caves where they were shielded from the Sun's destructive radiation and emerged into modern sunshine only after it had been tempered and screened by vapors, dusts, and gases which had developed as a result of early life and geologic processes. Primitive microbes could also have been protected by purine and pyrimidine bases which are capable of absorbing UV radiation.(*2*)

Dr. Keeve is medical director (Occupational Health) at the Medical Clinic, Naval Research Laboratory, Washington, DC 20375.

Far above the Earth, in the once remote and distant stratosphere, the effects of civilization on the layers surrounding us are being measured and monitored as we alter the various envelopes guarding our very existence. The ozone layer located about 20-25 kilometers from the Earth's surface screens out most of the harmful UV radiation. Thirty percent ozone layer depletion would double skin cancer prevalence by the year 2300.(*3*)

Sun Radiation

One can only see half the electromagnetic spectrum of the Sun reaching the surface of the Earth (Table 1, Figure 1). The sky appears blue as a result of the scattering of visible light by particles in the atmosphere. When skylight is unscattered it is called "sunlight." The very high end of the spectrum consists of very short ionizing X-rays and gamma-rays while the low or long end extends into the range of radio frequency radiation and probably beyond. These tail ends of the spectrum are important to many different disciplines and scientists but have little direct biologic significance. The wavelengths from 100 to 400 nanometers (one nanometer (nm) equals a billionth of a meter) called "ultraviolet" are invisible to the naked eye but have great biologic significance. The ultraviolet (UV) band has been subdivided into three narrow segments according to their photobiologic effects.(*4*)

The C-band (UVC) consists of radiation less than 280 nm which can kill one-celled organisms such as bacteria, viruses, and fungi but very few of these rays reach the earth and it is produced artificially when needed by special lamps. The A-band (UVA) radiation between 320 and 400 nm can produce skin-tanning but is not considered an important health hazard because it, too, is not an abundant portion of the spectrum. The narrow B-band (UVB) 290-320 nm is the radiation with the most important biologic importance and reaches the Earth's surface in sufficient amounts to cause skin damage.

TABLE 1. Classification of Solar Radiation

Radiation	Wavelength Range
Cosmic rays	0.00005 nm
Y-Rays	0.0005-01.4 nm
X-rays	0.01-10 nm
Vacuum UV	1-200 nm
Ultraviolet C (UVC)	200-290 nm
Ultraviolet B (UVB)	290-320 nm
Ultraviolet A (UVA)	320-400 nm
Visible light	400-740 nm
Near infrared	740 nm-1.5 μm
Middle infrared	1.5-5.6 μm
Far infrared	5.6-1000 μm
Microwaves and Radio waves	1000 μ-550 m

Source: From the University Burn Center, Charlottesville, VA

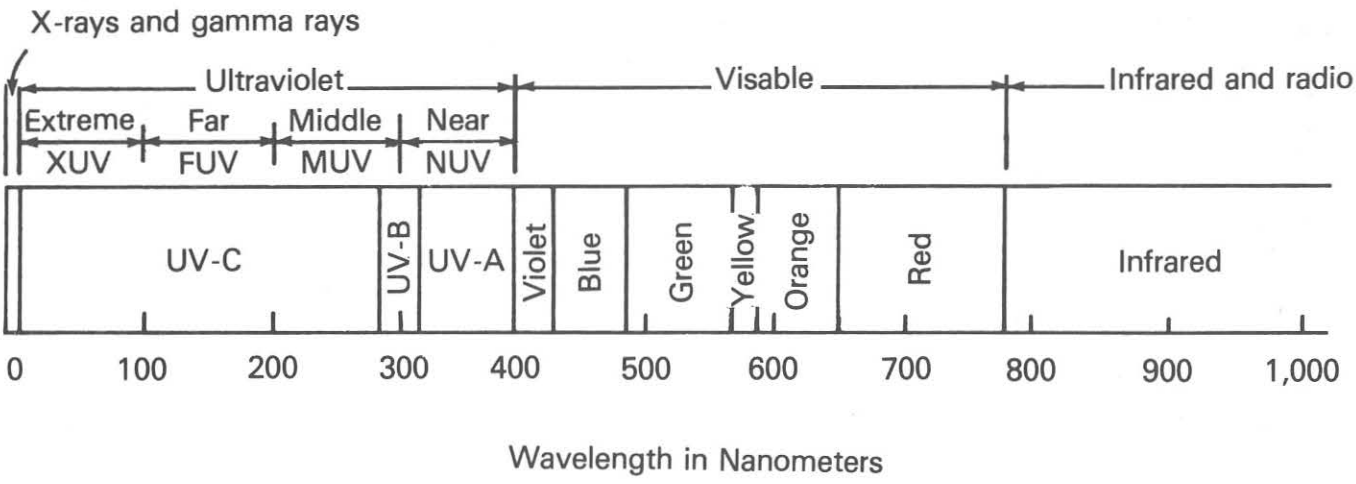


FIGURE 1. The electromagnetic spectrum. (Adapted from Environmental Studies Board, 1973).(6)

UVB can produce cumulative and irreversible skin changes by altering the DNA (deoxyribonucleic acid) in cells and is responsible for premature skin aging (wrinkling and thickening) seen in sailors, farmers, and ranchhands. The principal harm of UVB, however, is the sunburn and nonmelanoma skin cancer it causes.(*5*)

UVB Radiation and Skin Cancer

Nonmelanoma skin cancer (squamous and basal cell carcinoma) is almost always related to excessive sunlight exposure. Malignant melanoma is a major public health problem. The rate of mortality increase due to malignant melanoma is higher than any other malignancy except lung cancer. (*3*) The American Cancer Society estimates that there were 17,400 malignant melanomas in 1983 with 5,200 associated deaths and that by the year 2000, one person out of 150 will develop malignant melanoma. This association was first reported in the late 19th century as a disorder among sailors according to Thiersch (1875) (*6*) and Unna (1894).(*7*) Evidence linking sunlight to skin cancer rapidly grew from both epidemiological and experimental studies. It is now well accepted that skin cancer is an ailment of light-complexioned people who sunburn easily, work in isolated areas outdoors, and it appears almost always on exposed parts of the body (Table 2).

The epidemiology of the disease is continually being monitored through clinical reports and a special network of Robertson-Berger UV meters designed to measure UV radiation intensity with the maximum erythema

TABLE 2. Annual Age-adjusted Incidence Rate (1977-1978) for Nonmelanoma Skin Cancer Among White Males According to Anatomic Site and Geographic Area, with UVB Index and Latitude (6)

	Seattle (King Co.)	Minn-St. Paul (SMSA)	Detroit (SMSA)	Utah (State)	San Francisco-Oakland (SMSA)	Atlanta (SMSA)	New Orleans (Metro)	New Mexico (State)	All Survey Areas
UV-B Radiation Index	101	106	110	147	151	160	176	197	(101-197)
Degrees North Latitude	47.5	44.9	42.2	40.7	37.8	33.7	30.0	35.1	(47.5-30.0)
All Anatomic Sites	256.5	249.7	172.1	450.5	287.9	554.2	562.9	443.5	310.4
Face, Head, or Neck	189.6	182.2	122.3	323.9	192.2	367.1	367.7	319.3	215.9
Trunk	29.2	25.2	13.4	25.7	28.6	50.5	33.7	23.5	25.6
Upper Extremities	8.8	8.9	8.9	28.9	20.7	39.3	62.0	22.3	19.4
Lower Extremities	2.1	3.0	2.2	2.1	4.0	6.2	4.4	3.2	3.2

dose standardized to read 100 percent at the 297 nm wavelength (Figure 2). The effects of latitude, altitude, and time, as well as local atmospheric conditions, are also taken into account (Figures 3, 4, and 5). About 400,000 light-skinned people will develop skin cancer in the United States each year, but this incidence may rise if clothing styles and recreational fashion promote increasing skin exposure to sunlight.(*8*) Sun-exposed skin of the elderly tends to be thinner than young skin resulting in increased basal cell layer exposure.(*3*) UVB radiation suppresses immune responses, wound healing, and may activate herpes simplex virus and other skin diseases and malignancies.(3) Where once a sun-darkened skin marked the social class of ordinary, working people, today it is a symbol of affluence and leisure. Parasols, chalks, oils, and creams were used to keep the skin fashionably pale.

Skin-tanning is a multimillion dollar industry hawking cosmetics, sun lamps, tanning parlors, and tropical, sun-filled holidays. The "sun-belts" are the fastest growing regions of the country. Those exposed to long hours of high-intensity sunlight must be aware of how to avoid the harmful effects of this health risk.

Protection and Treatment

Although the kind and quantity of radiation and energy reaching the Earth is fairly constant, it is modified by elevation, latitude, season, time, and local atmospheric conditions. Dust and water vapor merely scatter UV radiation but do not diminish its effects. Dull, hazy days can produce as much sunburn as bright sunshine. Water and snow reflect almost all UV light. The reaction and pain appearing 12-24 hours after exposure can be partially relieved by application of topical steroids or a 2.5 percent solution of indomethacin. Continuous protection from sunburn and possible cancer should be taken by all personnel who must work outdoors. A 5 percent solution of para-aminobenzoic acid (PABA) in a 50-70 percent alcohol is the best formula for protecting the

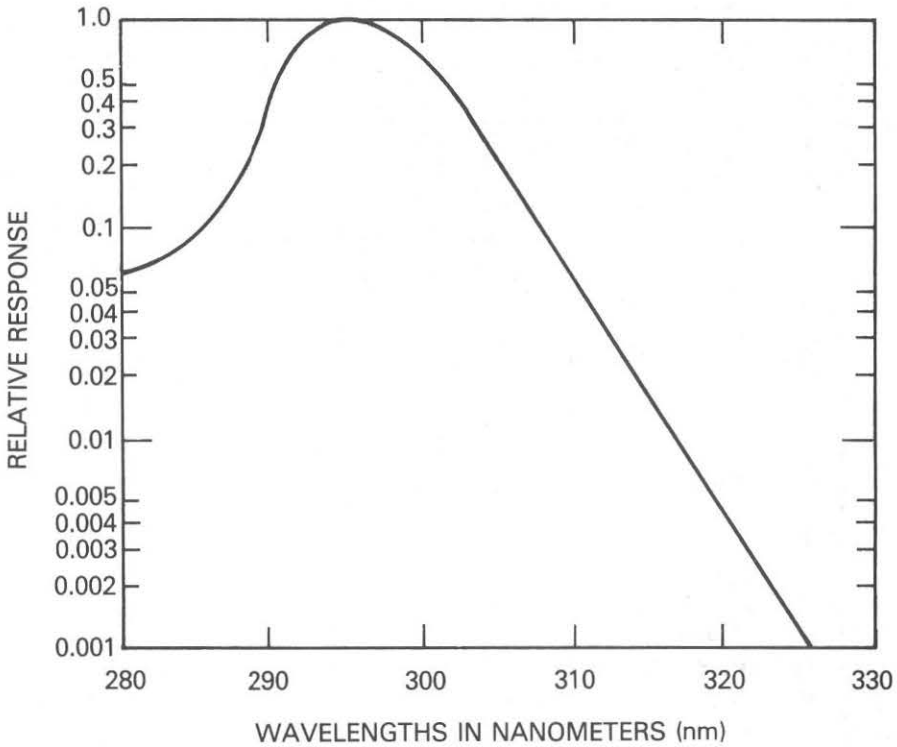


FIGURE 2. Erythema action spectrum.(6)

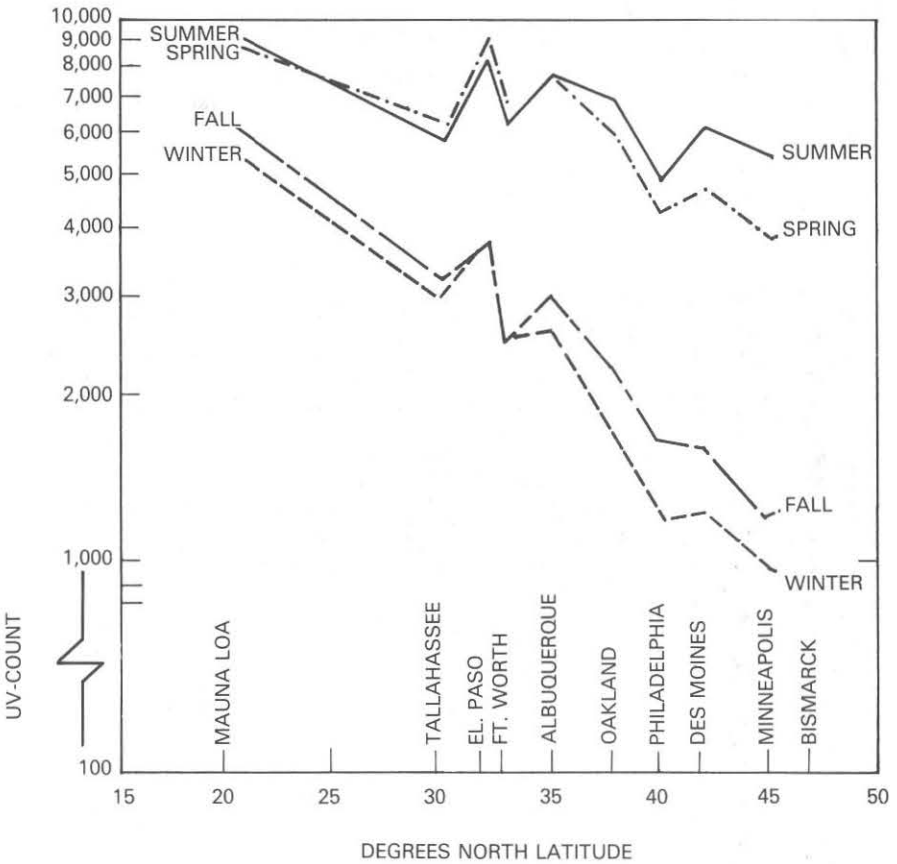


FIGURE 3. Average daily UVB count by season and latitude. (6)

skin from UVB rays. This solution should be applied over all exposed areas of the body after a warm shower and repeated daily as long as sun exposure is necessary. The PABA will penetrate and remain in the stratum corneum layer of the skin and will not wash away, yet it will still allow tanning.(9) The long-term effects such as skin-aging, however, may not appear until long years after you've forgotten the hours you spent on deck or shore "soaking up the rays."

Recommendations

- Make sure your pharmacy is well stocked with 5 percent PABA, steroids, and indomethacin solution.
- Encourage all hands, especially deck, CB, and other outdoor working personnel to make continuous use of the protective sunscreen solutions. You can easily gauge the effectiveness of your program by the number of sunburn cases attended in sickbay.
- Convince the Line commands to supervise personnel for appropriate protection in sunlight especially during the hours of 1100-1400.

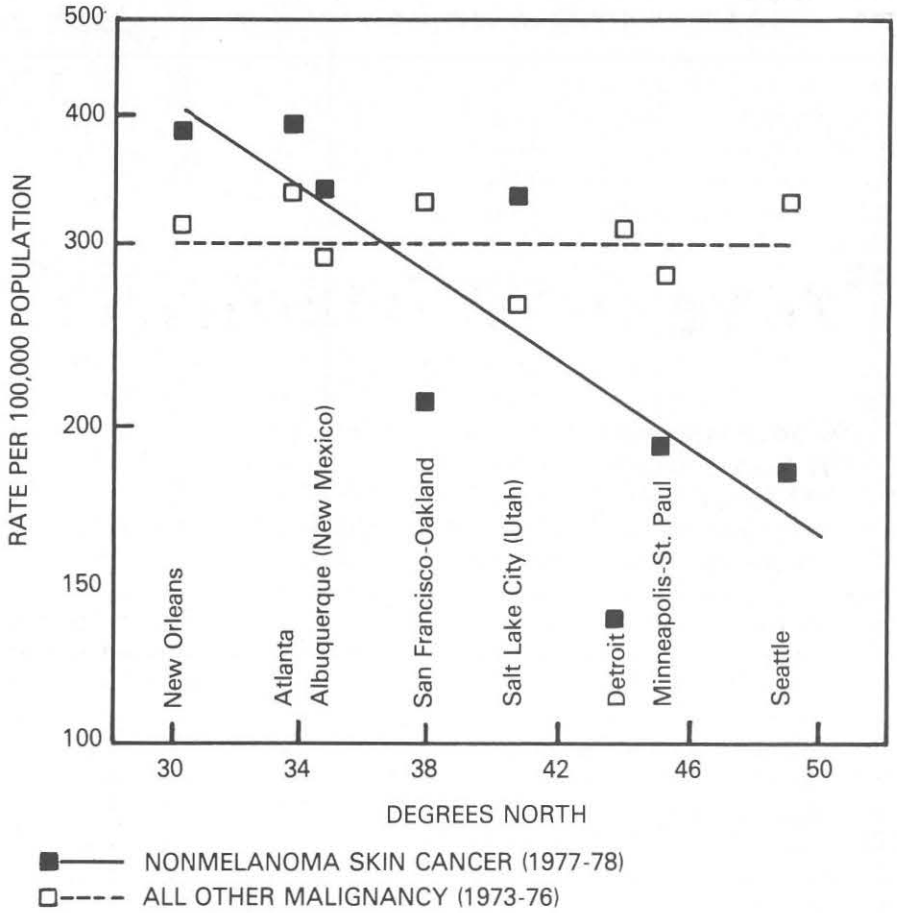


FIGURE 4. Annual age-adjusted incidence rates (1970 U.S. standard) for nonmelanoma skin cancer (1977-1978) and all other cancers (1973-1976) by latitude in the white population of the United States.(6)

FIGURE 5. Annual age-adjusted incidence rates (1977-1978) for nonmelanoma skin cancer among white males according to location.(6)

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Preventive Medicine Quiz

1. The blood carbon monoxide level of a nonsmoker is usually around 0.4 percent. Smoking one pack of cigarettes per day will elevate this level to:

(A) 1.2 percent
(B) 2.0 percent
(C) 0.8 percent
(D) 8.0 percent
(E) 5.0 percent

2. Which of the following occupational exposures is responsible for the majority of occupational skin cancer?

(A) Alpha and beta particles
(B) Ultraviolet light
(C) Coal tar
(D) Benzene
(E) Sulfur dioxide

3. Which of the following is NOT associated with occupational exposure to asbestos?

(A) Mortality from all asbetos-related causes is 2.8 times higher in smokers than nonsmokers.
(B) The latency for appearance of lung cancer is approximately 30-35 years.
(C) Gastrointestinal cancer incidence is increased.
(D) Smokers have approximately 90 times the risk of lung cancer than nonsmokers.
(E) Most people with radiographic evidence of asbestosis changes are symptomatic.

4. Occupational exposure to which of the following does NOT cause perforation of the nasal septum?

(A) Vanadium
(B) Nickel
(C) Arsenic
(D) Chromium

5. Which of the following toxic chemicals is found in scientific instruments, used as a mildew inhibitor in latex paints, a fungal inhibitor in wheat and barley, and can result in central nervous system damage which is reversible if caused by the vapor but irreversible if caused by the methyl form?

(A) Arsenic
(B) Vinyl chloride
(C) Beryllium
(D) Mercury
(E) Lead

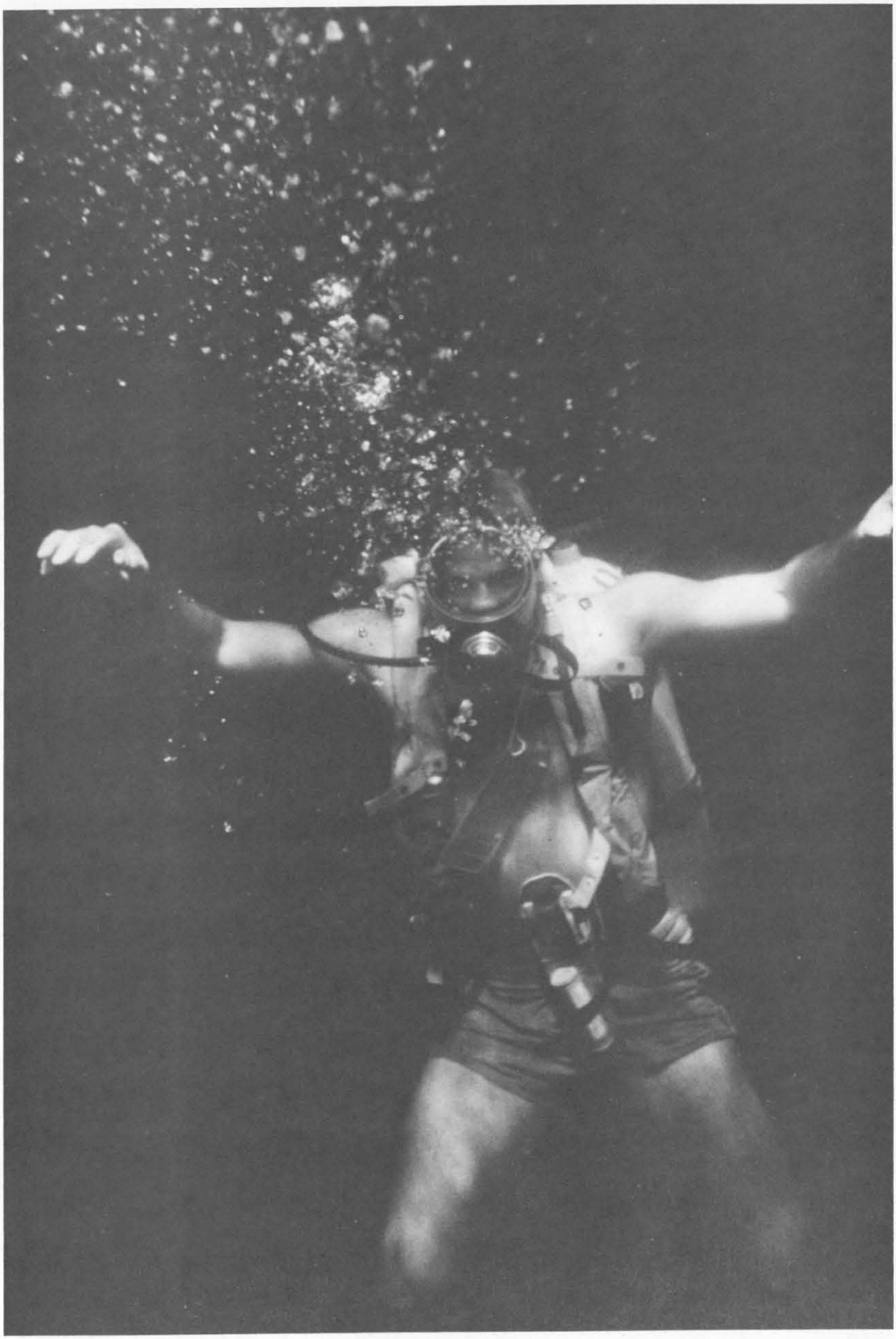
6. Which of the following substances emits beta and gamma radiation, can cause a hemangiosarcoma of the liver and spleen, and, before the harmful effects were recognized, had been used in an X-ray contrast material?

(A) Thorium
(B) Vinyl chloride
(C) Arsenic
(D) Thallium
(E) Osmium

7. Match the diseases resulting from occupational exposure to the following metals:

(1) Selenium	A. Usually due to inhalation; extra-pyramidal symptoms which respond to L-dopa therapy; used in production of steel, cast iron, and aluminum.
(2) Zinc	B. Oral intake causes classic triad of alopecia, gastroenteritis, and polyneuritis; previously used in treatment of syphilis, ringworm, and dysentery.
(3) Manganese	C. Fumes from cutting or welding galvanized metal cause symptoms of influenza and a metallic taste; usually complete recovery.
(4) Thallium	D. Important livestock diseases; causes "blind staggers" in humans; characteristic garlic odor of breath, metallic taste, and nail bed pain.

(Answers on page 28)



A Synopsis of Diving Medicine for Emergency Physicians

LCDR Donald C. Arthur, MC, USN

Each year, more people are enjoying the sport of SCUBA diving and, although most are well trained by professional instructors, inherent dangers await those who either forget their training or encounter an emergency for which they are unprepared.

This article is the first in a two-part series which outlines the basics of diving medicine and focuses on the pathophysiology, recognition, and treatment of diving-related illnesses.

Pressure Effects (Barotrauma)

At sea level, the atmosphere exerts a ubiquitous absolute pressure of approximately 760 mm Hg (= 29.9 inches Hg = 14.7 pounds per square inch (psi)). This is the standard 1 atmosphere absolute (1 ATA) pressure. As elevation is increased, this pressure is decreased in a nonlinear fashion so that the pressure at an altitude of 18,000 feet is one half that at sea level, one quarter at 34,000 feet, and so on. In contrast, pressure changes in water are linear; one atmosphere of pressure is added for each 33 feet of sea water (FSW) depth (34 feet for fresh water) so that the pressure at a depth of 66 feet is 3 ATA or 44.1 psi in sea water.

Dr. Arthur is senior medical officer aboard USS *Kitty Hawk* (CV-63).

The effect of this increased pressure is balanced by breathing air delivered at the new ambient pressure and by equalizing the pressure in all gas-containing body cavities to ambient.

Following Boyle's law, at a constant temperature, the volume of an enclosed gas varies inversely with the surrounding absolute pressure. Figure 1 illustrates the relationship between depth/pressure and volume; one can see that the greatest pressure changes occur at shallow depths. Most of the diving pathology related to pressure effects are a result of this pressure-volume relationship.

The Ear

Middle Ear Squeeze. The middle ear can be considered a gas-filled structure almost completely surrounded by bone. The fragile tympanic membrane (TM) is its only distensible part and the Eustachian tube its only normal avenue for gas venting. Unless additional air is allowed into the middle ear during descent, the tympanic membrane will be forced inward by the increasingly unbalanced ambient pressure. If this pressure is not equalized as a diver leaves the surface, a feeling of fullness will occur at a pressure differential of 60 mm Hg (3 FSW); equalization becomes nearly impossible between 90 and 120 mm Hg (4-5 FSW) because of a pharyngeal valve effect, and tympanic membrane rupture will follow at between 100 and 500 mm Hg (4.5-21 FSW).(*1,2,3,4*) These effects are most apparent in shallow water since the percent volume change is greatest near the surface.

As the differential pressure increases, the middle ear mucosa changes in a predictable pattern which is best observed in the tympanic membrane.

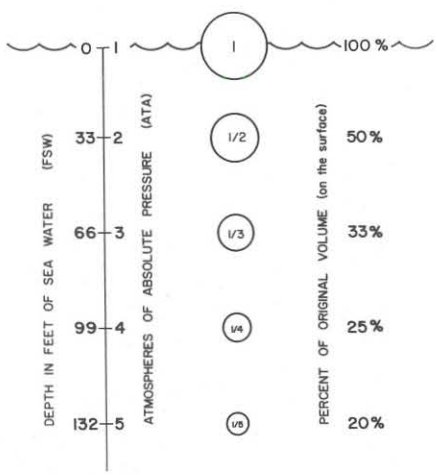


Figure 1. The relationship between pressure (or depth) and gas volume changes following Boyle's law. The greatest relative pressure changes (and, hence, volume changes) occur nearest the surface.

- TM capillary dilation
- Edema of the TM mucosa
- Hemorrhage into the TM and its mucosa
- Hemorrhage or serious transudation into the middle ear
- Tympanic membrane rupture (usually with acute relief of pain)

When TM rupture occurs in the water, vertigo may result from caloric vestibular stimulation. Hemorrhage and decreased TM compliance will usually produce a conductive hearing loss in severe cases. This spectrum of pressure imbalance effects is called ear barotrauma or ear "squeeze" and is the most common diving-related injury, more common in naive than experienced divers. These characteristic tympanic membrane changes have been used to classify ear squeezes into the five clinical categories listed in Table 1.(*5*)

While descending, experienced divers will "keep ahead" of their pressure imbalance, using a gentle Valsalva or Frenzel maneuver to clear their ears in advance of the feeling of fullness. When a diver feels pain, he is close to the differential pressure at which he will be unable to clear and his best remedy is to ascend to a depth of relief and gently try to clear again.

People who breathe 100 percent oxygen for prolonged periods often experience a mild delayed ear squeeze hours later as the oxygen is absorbed by the endothelium lining the middle ear, leaving a relative negative pressure in the middle ear. Uncommonly, a reverse ear squeeze can occur when air in the middle ear fails to vent through the Eustachian tube during ascent. The diver feels a fullness in the affected ear as the TM bulges outward and may perforate or cause alternobaric vertigo, a transient vertigo due to unequal middle ear pressure equilibration.

Depending on the severity, ear squeezes can be treated symptomatically with decongestants or a decongestant/antihistamine combination. Introducing compressed air into the nose while the patient loudly repeats "K..K..K..K" can force air into the Eustachian tubes. This is called politzerization and may be useful if a significant middle ear negative pressure persists and, antibiotics should be prescribed if the TM has been ruptured. If the hole is in the superior-posterior aspect, one should try to determine whether or not ossicular continuity has not been disrupted. ENT consultation may be necessary. Further diving should be postponed for the times listed in Table 1. Note that open TM perforations are an absolute contraindication to diving because of the risk of caloricallyinduced vertigo. Divers who cannot fully clear their ears at the surface should not dive!

External Ear Squeeze. If air cannot freely enter the external canal (because of cerumen impaction or the wearing of a tight-fitting wet suit hood or ear plugs) the resultant negative pressure in the canal will cause the TM to bulge outward and the lining of the canal can become edematous and, eventually, hemorrhagic. The diver will experience pain which is not ameliorated by middle ear equalization. The treatment is ascent. Divers should be sure that their hoods can vent properly and that their canals are relatively free of cerumen. Snorkling and SCUBA diving should *NEVER* be performed with ear plugs!

Round or Oval Window Rupture and Perilymph Fistula. A serious potential manifestation of inner ear barotrauma is rupture of the round or oval window. A pressure differential between the inner and middle ear can be created, causing either an implosive or explosive round or oval window rupture. This usually occurs close to the surface during a difficult descent as the inner-middle ear pressure differential is accentuated by a forceful Valsalva-induced increase in inner ear pressure.(*6*) Explosion can result from overpressurization of the cerebrospinal fluid within the inner ear (via the cochlear aqueduct) and implosion occurs when sudden equalization causes exaggerated movement of the ossicular chain.

Round or oval window rupture will be marked by the sudden onset of severe and long-lasting vertigo, roaring tinnitus, nystagmus, a feeling of fullness in the affected ear, and a sensory-neural hearing loss. Round or oval window rupture can be confused with alternobaric vertigo (see below), although the latter usually occurs during deep dives and is transitory, and with inner ear decompression sickness (see Part 2) which is most commonly associated with deep dives using a helium and oxygen breathing mixture. A trial of recompression is *NOT* indicated since further inner ear damage might result.

Whenever a diver presents with a symptom complex of vertigo with a sensory-neural hearing loss, inner ear barotrauma must be considered. The patient should be evaluated by an otolaryngologist for possible early surgical repair. An electronystagmogram and an audiogram are helpful in locating and assessing the extent of the fistula and antivertiginous drugs may be of benefit. Patients whose audiogram shows a flattened curve over all frequency ranges seem to recover more completely than those patients whose initial deficit is confined to the higher frequencies.

Most round or oval window ruptures heal spontaneously after 5-7 days of bed rest. Since meningitis is a potentially fatal consequence of a perilymph fistula, the physician should perform careful reexaminations.

Round or oval window rupture can be prevented by not diving when one has difficulty equalizing pressure at the surface, by using only gentle Valsalva or Frenzel maneuvers when relieving middle ear pressure, and by ascending when there is difficulty clearing. The Frenzel maneuver is preferred over the Valsalva maneuver since the Frenzel maneuver generates less intrathoracic, intracranial, and nasopharyngeal pressure.

Alternobaric Vertigo. Alternobaric vertigo is a sudden and overwhelming feeling of disorientation and spinning which is transient, occurs on ascent more frequently than descent,(*7,8,9*) and is thought to be caused by a usu-

ally unilateral pressure differential greater than 50 cm H_2O between the middle and inner ears.(*10,11,12*) The severe disorientation which occurs can be extremely hazardous in the water and may explain some of the mysterious deaths of experienced divers. It usually lasts less than a minute but can persist for hours.

Alternobaric vertigo on ascent is thought to be caused by an inability to equalize one or both ears. The diver will feel a fullness preceeding the onset of vertigo. The vertigo may persist on the surface and be accompanied by nausea, vomiting, and nystagmus without tinnitus. Decongestants usually hasten clearing and a myringotomy should be performed if the TM is bulging and the vertigo persists. An audiogram should be obtained to document any permanent hearing loss.

Alternobaric vertigo on descent usually follows a difficult descent with many forceful Valsalva maneuvers and sudden equalization. It is thought to be caused by a sudden middle ear overpressurization and/or rapid shift in the positions of the round and oval windows. The signs, symptoms, and treatment are the same as for alternobaric vertigo on ascent and can be prevented by descending slowly while gently equalizing middle ear pressure. A purely conductive hearing loss may signal dislocation of the stapes.

Rarely the facial nerve's blood supply can be compromised with resulting "alternobaric facial palsy" if the nerve is exposed to prolonged middle ear overpressurization.(*13*) Complete unilateral facial nerve palsy is the most extreme result but is, fortunately, transient and resolves as soon as circulation is restored by equalizing middle ear pressure.

Sinuses

Like the ears, the sinuses are air-filled spaces enclosed by bone and have only one avenue for pressure relief. Sinus squeezes occur much less frequently than ear squeezes and are usually associated with a preexisting upper respiratory infection which distorts the normal architecture of the ostia. Prophylactic decongestants administered just before diving have been beneficial.

Sinus squeezes most often involve the frontal and maxillary sinuses and usually occur on descent as the pressure differential increases between the sinus and ambient pressures. The mucosa becomes hyperemic, edematous, and, eventually, hemorrhagic; hematoma formation and frank bleeding from the nose are common. The diver will experience acute pain over the area corresponding to the affected sinus and a dull ache may persist after equalization. The immediate treatment consists of ascending to a depth of relief and gently trying to equalize, discontinuing the dive if symptoms persist. Adjunctive therapy is symptomatic and antibiotics are recommended if bacterial infection is superimposed. Hematomas may resolve slowly and diving activities should be suspended until they have symptomatically and radiologically cleared.

Uncommonly, a reverse sinus squeeze can occur on ascent if an ostium is obstructed by redundant mucosa, a polyp, or a mucous plug. While the symptoms will be the same as for a sinus squeeze on descent, the immediate treatment is to descend to a depth of relief and ascend slowly. Occasionally, paresthesias or numbness along the infraorbital nerve distribution may occur with a reverse maxillary sinus squeeze.(*14,15*)

Pulmonary Overinflation

Air in the lungs also follows Boyle's law. At a depth of 33 FSW, the lung volume of a snorkler who had inhaled to total lung capacity (TLC) at the surface will be one-half the original volume at the surface. Conversely, the lung volume of a SCUBA diver who inhales to TLC at 33 FSW and ascends will double by the time he reaches the surface. Constant exhalation is required to vent air from the ascending

TABLE 1. Ear Squeeze Clinical Categories (*5*)

Category	Description	Restriction From Diving
TEED 0	Normal	
TEED 1	Vascular congestion of pars flaccida, umbo, and anulus; occurs at pressure differential of 100 mm Hg	1-3 days
TEED 2	Vascular congestion of entire tympanic membrane; occurs at pressure differential of 100-150 mm Hg	1-3 days
TEED 3	Hemorrhage within tympanic membrane	1 week
TEED 4	Hemorrhage into middle ear with or without TM rupture*	4-6 weeks
TEED 5	Hemorrhage fills middle ear	4-6 weeks

*Open TM perforation is an absolute contraindication to diving because of the risk of calorically-induced vertigo.

SCUBA diver's lungs so that this increasing volume won't overpressurize the fragile alveoli. Failure to do so will result in alveolar rupture with escape of air in one of three pathologic directions to produce interstitial emphysema, pneumothorax, or arterial gas embolism (Figure 2). The results are serious and dramatic. The usual cause of an overinflation accident is inadvertent breathholding during an emergency ascent by an inadequately trained diver.

Since the greatest pressure and volume changes occur near the surface, this is also the area of greatest danger. An overpressurization of only 90 cm H_2O is necessary for alveolar rupture to occur(*16,17,18*) and, near the surface, this can be attained in less than 6 FSW! Thus, holding one's breath for only the last 6 feet of ascent can result in pulmonary overinflation. These figures show some individual variation and preexistent pulmonary pathology which causes a decrease in lung compliance has been shown to increase the risk of pulmonary overinflation.(*19*)

Interstitial Emphysema. Interstitial emphysema is always present with alveolar air escape and may be its only manifestation. This air can dissect into the mediastinal space and, from there, into the pericardium, cephelad into the neck as subcutaneous air, or caudally as retroperitoneal air. Signs and symptoms include varying degrees of supraclavicular crepitus, change in voice timbre, substernal crunching, sounds of pericardial air, compromised venous return from the head, obvious X-ray findings, and dyspnea. Unless the pericardial air severely compromises circulation, or the mediastinal or cervical air hinders breathing, interstitial emphysema is not life-threatening and can be treated symptomatically with complete resolution expected in a few days. Breathing 100 percent oxygen can hasten resolution but is not generally recommended. Pericardiocentesis or intubation may be required in selected cases.

Although not inherently dangerous, the presence of interstitial emphysema does indicate the escape of alveolar air and the physician must closely examine and monitor the patient for the other, more serious, consequences of pulmonary overinflation described below.

Pneumothorax. Pneumothorax is a sequela of air extravasation from alveoli adjacent to the pleura, especially in a diver with preexisting blebs. The signs and symptoms are the same as for a pneumothorax on the surface and the pneumothorax is usually neither under tension nor life-threatening. Placement of a chest tube is sometimes indicated and a thorough physical examination should be made to rule out a concomitant arterial gas embolism. If recompression therapy is initiated for a co-existing arterial gas embolism or decompression sickness in a diver with a pneumothorax, a chest tube must be inserted prior to decompression to prevent tension from developing on ascent. A Heimlich valve can be used to permit greater mobility within the normally small recompression chamber.

Arterial gas embolism. Arterial gas embolization is, by far, the most serious and rapidly fatal of all diving accidents and is second only to drowning as the leading cause of death associated with sport diving. Air bubbles which enter the pulmonary capillaries coalesce and travel via the pulmonary veins to the left atrium where they are directed into the left ventricle. From the left ventricle, some of the air obeys the law of gravity (which says that its distribution is proportional to the gravity of the consequences) and enters either the coronary arteries or the cerebral circulation via the carotid and vertebral arteries. The combined effects of air which enters the coronary arteries and air entering the vertebral artery circulation can have a dramatic effect on coronary circulation and myocardial function.(*20,21*) Cerebral air has essentially the same effects as any embolic disruption of circulation: decreased local blood flow distal to the obstruction, accelerated intravascular coagulation, increased capillary permeability and leakage, and edema of surrounding tissues.(*22,23,24,25,26,27,28,29,30*)

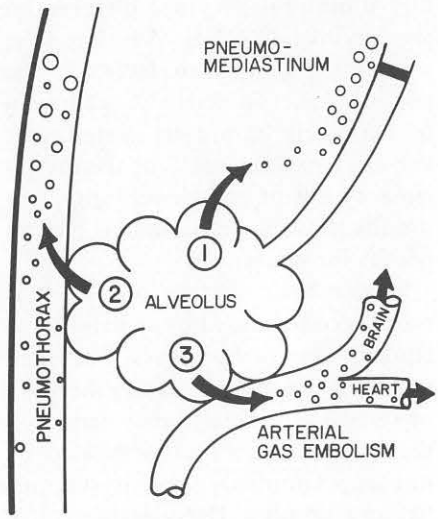


Figure 2. Air released from an overpressurized alveolus can extravasate in one of three pathologic directions to cause (1) interstitial emphysema and pneumomediastinum, (2) pneumothorax, or (3) arterial gas embolism.

Arterial gas embolization occurs on ascent and the time from alveolar rupture to manifestation of symptoms is nearly always *less than 10 minutes*. A complete neurologic examination is essential to pick up the often subtle manifestations of air embolization. By signs and symptoms, patients have been divided into two general groups. (*31*)

Group 1: Those presenting with neurologic symptoms but without impairment of spontaneous respiration and cardiac function. These neurologic symptoms can range from subtle changes in mood or affect to the more usual global affects presenting as immediate unconsciousness.

Group 2: Those presenting with apnea, loss of consciousness, and cardiac dysrhythmia or arrest.

The pathogenesis of symptoms in Group 1 is a localized obstruction of cerebral blood flow by an embolus of air. Local capillary endothelial damage results in vasogenic edema with prompt extravascular movement of small molecules and somewhat

delayed (30-60 minutes) leakage of large molecules from cerebral vessels.(*25,30,32*) The combined effect is an increase in total brain water content beginning approximately 30 minutes after embolization and lasting nearly 24 hours. Intracranial pressure has been shown to rise almost immediately, peaking in 1 hour, and remaining elevated for several hours.(*28*)

There have been two mechanisms proposed for the cardiac effects of air embolization (Group 2).(*20*) Embolization of the coronary arteries causes direct circulatory disruption and may result in progression from ischemia to infarction. Dysrhythmias may also occur. Air entering the posterior cerebral circulation produces dysrhythmias and marked hypertension. Both cerebral effects can be blocked by lidocaine in the 5 mg/kg dosage range in animals, although the dose is not yet accepted in man.

Definitive treatment of any gas embolism requires a recompression facility and expeditious transportation is vital. The following steps are recommended while in transit:

1. Assure adequate airway, ventilation, and circulation. Intubated patients should be hyperventilated to decrease intracranial pressure. *NOTE:* Endotracheal tube and foley catheter cuffs must be filled with water to avoid volume changes during recompression treatment.

2. Administer 100 percent oxygen by the most efficient means (rebreathing mask if not intubated).

3. Treat any dysrhythmias or cardiac arrest with the ACLS protocol; dysrhythmias caused by bubble embolization into coronary arteries will tend to be refractory to treatment until the bubble is reabsorbed or reduced in size by recompression.

4. Treat hypotension with pressors such as dopamine in doses of 1-10 ug/kg/min to increase coronary artery blood flow, cardiac output, and renal blood flow without increasing myocardial oxygen demand.

5. Administer a bolus of dexamethasone; large doses (1.0-1.5 mg/kg) have been recommended over lower doses (0.2 mg/kg) in treatment of head trauma and cerebral edema.(*33*)

6. A foley catheter should be inserted.

7. Transport the patient in the supine position. Ground transportation is preferred but, if air transportation is used because of the distance to be covered, cabin altitude pressurization should be kept as close to sea level as possible or below 500 feet altitude above the site of injury for helicopters and unpressurized aircraft, consistent with safety of flight.(*34*)

8. If transportation is delayed, intravenous crystalloid with glucose should be started through a large bore catheter at less than daily maintenance rates.(*35*)

9. Valium may be administered in 5 mg IV boluses to a maximum dose of 30 mg for control of seizure activity as well as for sedation and to increase compliance with an endotracheal tube. (*35*) Barbiturates are the drugs of second choice.

10. Hypertonic solutions such as mannitol should *NOT* be used routinely because of the risk of a rebound increase in intracranial pressure. Their use should be reserved for cases of impending herniation.

The proper positioning of an air embolism patient has been controversial. Early studies(*36*) have shown that embolization while in the head-up position rapidly distributes air primarily to the cerebral circulation. In the head-down position, the coronary arteries receive a greater proportion. When supine as well as in the left lateral decubitus position, air is distributed to both the cerebral and coronary circulations. Although a vital organ will be embolized in any position, survival in the face of *repeat embolization* is probably greatest in the head-down position. The head-down position can, however, also cause an increase in cerebral blood flow and a further increase in intracranial pressure.(*37,38, 39,40*) In contrast, cerebral circulation may fall to unacceptable levels in the head-up position if there is systemic hypotension. The best position for transportation, therefore, is probably supine with the head in a neutral position to allow unrestricted arterial and venous blood flow.(*40*)

Definitive treatment will be rendered by the recompression facility personnel during recompression. The patient is usually recompressed for 30 minutes at a treatment depth of 165 FSW (6 ATA) which mechanically reduces the size of the offending bubble (following Boyle's law) to enhance passage of the bubble through the capillary circulation. After 30 minutes at 165 FSW, the pressure is reduced to 60 FSW (2.8 ATA) where the patient breathes 100 percent oxygen alternating with short air breathing periods to prevent oxygen toxicity. Therapy with hyperbaric oxygen improves tissue oxygenation, reduces intracranial pressure,(*41*) and provides a large diffusion gradient to air bubble absorption.

After treatment, the patient should receive a thorough neurologic examination including an electroencephalogram (EEG), cardiology examination including an electrocardiogram (EKG) and myocardial scanning with thallium and technetium,(*42,43*) and pulmonary examination including chest X-rays and volume/flow studies. A patient's fitness for continued diving will depend on the post-treatment evaluation and will be precluded by evidence of neurologic sequelae or pulmonary air trapping. Patients successfully treated for air embolism should wait at least 30-90 days before diving again.

Miscellaneous Pressure Effects

Tooth Squeeze. Air within a tooth, either in an area of decay or forced under a filling during descent, will also obey Boyle's law. Extreme pain is the usual manifestation of a tooth squeeze which occurs on ascent when the trapped air expands and causes an increased pressure within the tooth. The pressure is occasionally relieved when the filling becomes dislodged; otherwise, recompression in a chamber is indicated. Occasionally, direct mechanical decompression is attempted by drilling but is less than

universally successful. Tooth squeeze can be prevented through careful dental hygiene and a program of regular professional dental care.

Mask Squeeze. On descent, a negative pressure will be created within the diving mask if the diver fails to ventilate the mask adequately. Subcutaneous capillary flushing and small hemorrhages are common but benign effects.

G-I Squeeze. An intra-abdominal pressure sensation can be created by bowel gas which regionalizes during a dive and expands in a localized area during ascent. The pressure is relieved when the gas is redistributed.

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Answers from Preventive Medicine Quiz page 19

1. E

Blood carbon monoxide levels (carboxyhemoglobin) will be increased from 0.4 percent to 5 percent by smoking one pack of cigarettes per day. Heavy smokers (3-4 packs per day) can raise their blood carbon monoxide level up to between 5 and 9 percent; the level at which clinical symptoms begin due to diminished hemoglobin oxygen carrying capacity. Interestingly, aviators who smoke can diminish their oxygen carrying capacity such that their blood oxygen content at sea level is equivalent to being at an altitude of 7,600 feet!(*1*)

2. B

More occupational workers are exposed to ultraviolet light than any of the other agents listed, resulting in a spectrum of disease from relatively benign changes to squamous cell carcinoma.(*2*)

3. E

Compared to the general population, asbestos workers suffer from an increased incidence of cancer of the lung, esophagus, stomach, colon-rectum, larynx, pharynx, buccal mucosa, and kidney, as well as pleural and peritoneal mesothelioma. A latent period of 30-35 years is common. Chronic exposure can also result in diffuse interstitial fibrosis (the small, tight lung), yet persons with X-ray evidence of fibrosis, usually in the lower lobes, usually are asymptomatic.(*3*)

4. A

Chronic occupational exposure to nickel, arsenic, and chromium have been known to cause nasal septal perforation. In addition, exposure to nickel can cause cancers of the lung and nasal cavity, usually epidermoid or anaplastic. Exposure to arsenic can also cause skin, lung, and liver cancer. Chromium workers are exposed to hexavalent chromium which is a respiratory irritant, contributing to an increased incidence of bronchogenic carcinoma.(*4*)

5. D

Above a threshold level, poisoning with mercury causes a dose-related spectrum of paresthesia, ataxia, dysarthria, deafness, and death. Prenatal life is the most susceptible time and approximately 10 percent of an absorbed dose is sequestered in the brain. Widespread irreversible illness has been found in areas of famine where seeds treated with methyl mercury were distributed for planting but were used instead as a primary food supply. Subsequently, mercury-treated seeds have been colored red to prevent misuse. Mercury vapor causes a classic triad of reversible tremor, gingivitis, and erethism (excessive irritability or sensitivity to stimulation).(*5*)

6. A

Thorium, vinyl chloride, and arsenic are the three carcinogens which have been linked to the rare hemangiosarcoma of the liver and spleen. Until the mid-1940's, thorium had been employed as Thorotrast, a contrast material particularly useful for arteriography, venography, and highlighting sinuses. In addition, granulomas which later transformed to malignancies were noted at the injection sites and aplastic anemia, hemolytic anemia, Di Guglielmo's syndrome, myelofibrosis, and leukemia also appeared approximately 20 years after exposure.(*6*)

7.

(1) Selenium	**D.** Important livestock diseases; causes "blind staggers" in humans; characteristic garlic odor of breath, metallic taste, and nail bed pain.
(2) Zinc	**C.** Fumes from cutting or welding galvanized metal cause symptoms of influenza and a metallic taste; usually complete recovery.
(3) Manganese	**A.** Usually due to inhalation; extra-pyramidal symptoms which respond to L-dopa therapy; used in production of steel, cast iron, and aluminum.
(4) Thallium	**B.** Oral intake causes classic triad of alopecia, gastroenteritis, and polyneuritis; previously used in treatment of syphilis, ringworm, and dysentery.

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Audiovisual Productions

The Naval School of Health Sciences (NSHS) Bethesda, has acquired the following Army, Air Force, and commercial adopted subjects for use in emergency medical care training. These videocassettes are available for loan in 3/4-inch U-matic format or for ships in 1/2-Beta format.

Army

25957DN Management of Combat Wounds—Debridement and Delayed Primary Closure of Low Velocity Fragment Wounds
25985DN Arterial Injury by High and Low Velocity Missiles
25994DN Management of Combat Wounds—Thoracic Injuries
26000DN Missile Wound Evaluation—A Comparative Study
29778DN Psychological Casualties: Part 10
29823DN Personal Hygiene in a Cold Climate
33294DN Emergency and Partial Decontamination
33295DN Complete Personnel Decontamination
65196DN NBC Proficiency—Individual Standards
67551DN Chemical Protective Clothing, Part I, Types, Use and Donning
700152DN How to Recognize and Treat Severe Symptoms of Nerve Agent Poisoning (Buddy-aid)

Air Force

52981DN Medical Red Flag—Neurological Injuries
52982DN Medical Red Flag—Gunshot Wounds and Vascular Injuries, Part I
52983DN Medical Red Flag—Gunshot Wounds and Vascular Injuries, Part II
52984DN Medical Red Flag—Gunshot Wounds and Vascular Injuries, Part III
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